We gratefully acknowledge the following individuals (in alphabetical order) for their input and review of these adaptation examples: Scott Andrews, Carol Berzonsky, Sam Brody, Lesley Ewing, Darlene Finch, Murielle Gamache-Morris, Nancy Gassman, Jessica Grannis, Marian Hanisko, Adrianne Harrison, Brian Helmuth, Amy Holman, Ed Knight, Penny Larin, Debra Lekanoff, Becky Lunde, John Marra, Charles O'Hara, Becky Smyth, Skip Stiles, Heidi Stiller, Heather Stirratt, Ben Strauss, Missy Stults, LaDon Swann, Jim Titus, Susanne Torriente, and Emily Wallace. While they much improved the descriptions, neither they nor the organizations with which they are affiliated are held responsible for the contents. All omissions and oversights remain those of the author team.

COASTAL ADAPTATION EXAMPLES

The examples of adaptation activities listed here do not claim to be representative, comprehensive, or unique. Instead, they aim to show the diversity of possible approaches, the range of stakeholders and levels of government involved, and illustrate the fact that adaptation efforts are underway at every stretch of coastline across the nation. The need for scientific information to adequately support these efforts is growing rapidly.

Short tag line (on graphic)	Extended description (clickable or on accompanying pdf)	References (with extended text)	Graphic/Photo to accompany extended description (not on graphic)
Northeast			
Portland, ME is assessing costs for retrofitting its wastewater infrastructure.	Portland, ME expects a range of consequences from tidal flooding associated with sea level rise on its coastal sewer system (pers. comm. from C. Crovo, Portland Water District, to P. Kirshen): higher groundwater table (causing increased infiltration), increase in inflow during extreme rain events, loss of function of some combined sewer outlets (causing backups on streets and homes and the need for additional pumping), and bank erosion. These impacts would require stabilization around infrastructure, more pumping of sewage, and more treatment at the wastewater treatment plant.	Natural Resources Council of Maine (2006). Maine Coast Could Be Devastated by Global Warming. Retrieved from: http://www.nrcm.org/news_detail.asp?news=936 Wake, C. et al. (2009). *Climate Change in the Casco Bay Watershed: Past, Present, and Future.* Retrieved from: www.cascobay.usm.maine.edu/pdfs/Climate_Change_in_Casco_Bay.pdf Portland Water District (2011). *Proposed Comprehensive Budget Report, Fiscal Year 2012*, Portland, ME. Retrieved from: http://www.pwd.org/pdf/Budget2012.	 Portland, ME, Old Port Waterfront Source: Ken Gallager, Wikimedia Commons

Short tag line (on graphic)	Extended description (clickable or on accompanying pdf)	References (with extended text)	Graphic/Photo to accompany extended description (not on graphic)
	Already, some of the Portland Water District's pumps flood now during extremely high tides (PWD 2011: p.195) and are therefore being upgraded with a submersible system less vulnerable to service interruptions. Climate change and sea level rise for the region were assessed by NRCM 2006; Wake et al., 2009) A possible adaptation strategy was developed in a study done by Merrill et al (2012 in collaboration with Portland stakeholders. Over the next 25 to 50 years (2035-2060) the Portland Water District would elevate some manholes, seal others, line pipes, or replace pipes with tighter joints. Ideally, such infrastructure upgrades would be undertaken in the course of regular replacement and repair of the interceptor system, but still could cost between $6 and $12 million in addition to present normal maintenance and replacement costs. These costs would be incurred even if a	pdf Merrill, S., P. Kirshen, D. Yakovleff, S. Lloyd, C. Keeley, and B. Hill (2012). *COAST in Action: 2012 Projects from New Hampshire and Maine*. New England Environmental Finance Center Series Report #12-05. Portland, Maine.	

Short tag line (on graphic)	Extended description (clickable or on accompanying pdf)	References (with extended text)	Graphic/Photo to accompany extended description (not on graphic)
	seawall or hurricane barrier to protect the rest of the city were built. By 2050, a major decision would be made on how to further adapt the interceptor system and pump station (including possible options such as moving their locations further inland) in the face of increased tidal flooding due to higher sea levels. Costs for protecting the system from such higher tidal flooding are estimated at $20-35 million, not including the cost of moving the pumping station. Both a hurricane barrier and a seawall would not lessen the hydraulic forces on the interceptor system; they would only, if properly sized, prevent storm surge damage to the pump station. Experts expect such protection not to be necessary until 2050 (Merrill et al. 2012)		

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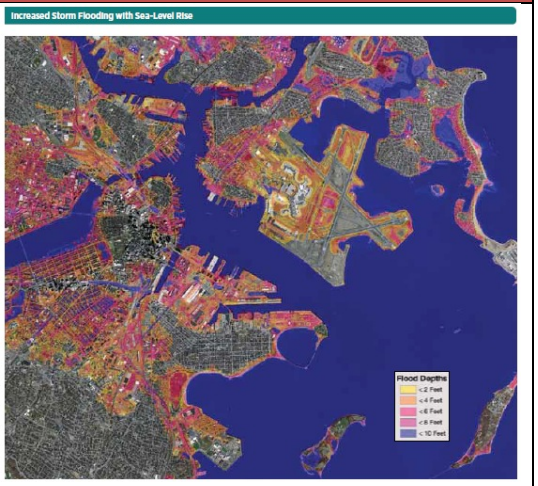
New Hampshire's Coastal Adaptation Workgroup is providing education, guidance and networking for local planners.	The New Hampshire Coastal Adaptation Workgroup (NHCAW) is a collaboration of 16 organizations working to help communities along the state's seacoast prepare for the effects of extreme weather events and long term climate change. NHCAW provides communities with education, facilitation and guidance; has conducted several educational and networking workshops (NHCAW 2012); fosters exchange and learning across the region NHCAW blog); and is building collaborative ties among municipalities, state and federal agencies, environmental groups, and scientists from local universities. The group is actively integrating disaster preparedness through the StormSmart program with long-term planning for climate change.	StormSmart Coasts – NH: http://nh.stormsmart.org/before/climate-preparedness/ New Hampshire Climate Adaptation Workgroup (NHCAW, 2012) (website). Retrieved from: http://nh.stormsmart.org/before/ed-outreach/past-workshops/ NHCAW Blog: The Crow's Nest. Retrieved from: http://nhblog.stormsmart.org/	 Source: NASA, Hurricane Irene (August 11, 2011)
City of Boston considers adaptation and mitigation equal	The City of Boston has an active history of engagement in climate change management dating back to 2001. Located at the confluence of several rivers and the Atlantic coast, the city faces many of the infrastructure	City of Boston (2011). *A Climate of Progress, City of Boston Climate Action Plan Update, 2011*. Retrieved from: http://www.cityofboston.gov/Images_Documents/A%20Climate%20of%20Progress%20-	

Short tag line (on graphic)	Extended description (clickable or on accompanying pdf)	References (with extended text)	Graphic/Photo to accompany extended description (not on graphic)
priorities, and sea level rise is a top concern.	adaptation challenges common to older coastal cities. Some of the challenges the city faces were initially described in the US EPA-funded Climate's Long-term Impacts on Metro Boston (CLIMB) project (1999 to 2004) (Kirshen et al., 2004) and a climate impacts assessment sponsored by the Union of Concerned Scientists in 2007 report (Frumhoff et al., 2007). City staff have further documented impacts. Spurred by these efforts, and particularly realizing that the various infrastructure sectors impact each other (e.g. Kirshen et al. 2008), the City released a first Climate Action Plan in 2007, and embarked on a long-term, continuous plan to both mitigate greenhouse gases and adapt to climate change and sea level rise. With broad expert and community stakeholder involvement (Climate Action Leadership Committee and Community Advisory Committee 2010), the CAP was updated in 2011 (City of Boston, 2011).	%20CAP%20Update%202011_tcm3-25020.pdf Kirshen, P., Ruth. M., and Anderson, W. (2008). Interdependencies of Urban Climate Change Impacts and Adaptation Strategies: A Case Study of Metropolitan Boston USA. *Climatic Change*, 86:105-122. Kirshen, P., Ruth, M., Anderson, W., and Lakshmanan, T.R. (2004). Infrastructure Systems, Services and Climate Change: Integrated Impacts and Response Strategies for the Boston Metropolitan Area, Final Report to US EPA ORD, EPA Grant Number: R.827450-01. Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D. J. Wuebbles 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. A report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists. Climate Action Leadership Committee	 Source: City of Boston CAP Update, 2011, p.9.

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	Planning is coordinated by a working group of eight city agencies under the leadership of the Office of Environmental and Energy Services. While coordinating with others, each major agency is attempting to go as far in adaptation planning as they can on their own. There is also cooperation with non-governmental organizations and other levels of government. Adaptation efforts are already being implemented (see City of Boston, 2011), including: (1) The Boston Conservation Commission (which protects and preserves open space, and permits development near wetlands) requires applicants to consider sea level rise over the design life of projects; (2) the Boston Redevelopment Authority (which carries out planning and economic development activities, and permits large projects) is asking developers of new projects to consider effects of climate change and, in the case of the	and Community Advisory Committee (2010). Sparking Boston's Climate Revolution. Recommendations to the Mayor of Boston. Boston Climate Action. Retrieved from: http://www.cityofboston.gov/Images_Documents/Sparking%20Bostons%20Climate%20Revolution%20Summary%20Report_tcm3-16527.pdf City of Boston climate action website: http://www.cityofboston.gov/climate/default.asp City of Boston adaptation website: http://www.cityofboston.gov/climate/adaptation/ Metropolitan Area Planning Council climate adaptation planning website: http://www.mapc.org/regional-climate-change	

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	large-scale 6.3 million square-foot project in South Boston, required that all of the components of the plan comply with present and future state and city sea level rise strategies; (3) Emergency Preparedness includes climate change in current planning efforts for emergency operations and natural hazards mitigation; (4) The Boston Water and Sewer Commission has begun long-range planning that explicitly includes sea level rise and greater storm intensity as important factors for the storm water and sewer system; and (5) the City is part of the federal-state-local management team for the Boston Harbor Islands, which is presently monitoring wetland conditions and prioritizing management of threatened coastal resources under different scenarios of climate change and sea level rise. In addition, the regional Metropolitan Area Planning Council (MAPC) – a planning		

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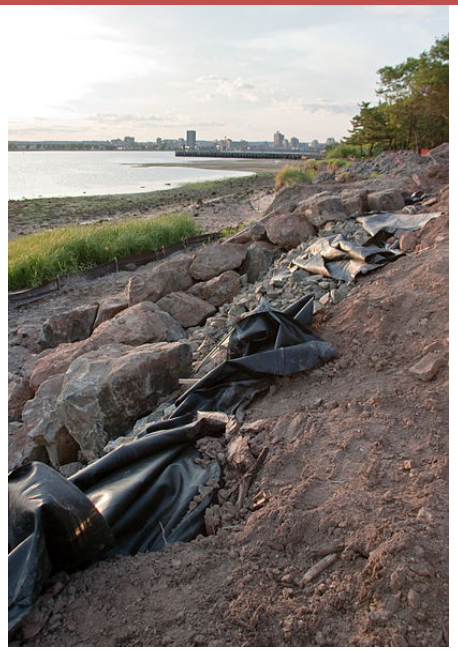
	agency supporting coordinated planning among the 101 cities and towns of the Boston metropolitan area – is developing a Regional Climate Change Adaptation Strategy. This strategy aims to prepare recommendations for local, regional and state action to reduce vulnerability from the anticipated impacts of climate change such as flooding, sea level rise, temperature increase and heat island effect, increased intensity and frequency of storms, seasonal drought, and so on (MAPC 2013).		

Short tag line (on graphic)	Extended description (clickable or on accompanying pdf)	References (with extended text)	Graphic/Photo to accompany extended description (not on graphic)
Connecticut State Assembly amended the state's Coastal Management Act to promote adaptation to sea level rise.	In May 2012, the Connecticut State Assembly passed legislation to amend the Connecticut Coastal Management Act (CCMA) to enhance efforts in hazard mitigation in light of sea level rise. Measures include moving structures back from the shoreline, elevating them, or restoring and building dunes to enhance natural buffers. The amendments to the CCMA also require localities to consider the potential impact of a rise in sea level in local land use plans. The Act extended the list of properties that can seek shoreline armoring permits to cemeteries, burial grounds, and inhabited residential structures built after January 1, 1995. However, these properties must show that armoring is necessary and unavoidable and must consider a list of feasible alternatives to armoring including relocation of the structure inland, elevation of the structure, and creation of dunes, vegetated slope, and living shorelines. In addition, the state in February	Prevost, L. (2012). To repair the shore, or retreat? *The New York Times*, May 3, 2012. Shoreline Preservation Task Force: http://www.housedems.ct.gov/Shore/index.asp Connecticut Climate Change website: http://ctclimatechange.com/	 Riprap to fortify the shoreline at East Shore Park, New Haven, CT Source: Wikimedia Commons, photo by "Versageek"

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	2012 created a bipartisan Shoreline Preservation Task Force to study the effects of storms, climate change and sea level rise on the Connecticut shoreline. It is charged, in particular, with identifying long-term solutions, including the question of coastal retreat/managed realignment (http://www.housedems.ct.gov/Shore/index.asp). The state is currently in the process of revising its draft adaptation (preparedness) plan, which includes a focus on coastal infrastructure (see http://ctclimatechange.com/)		
Mid-Atlantic			
Delaware launched a multi-faceted effort to prepare coastal communities for sea level rise.	To help assess, prepare for and minimize the potential impacts of sea level rise, the Delaware Coastal Programs Section of the Delaware Department of Natural Resources and Environmental Control is leading a multi-year Sea level rise Initiative (DCP 2011). All Initiative projects are summarized in an at-a-glance inventory and include scientific	Delaware Coastal Program (DCP, 2011). *Sea-Level Rise Initiative. Project Compendium*, September 2011. DCP: Dover, DE. Retrieved from: http://www.dnrec.delaware.gov/coastal/Documents/SeaLevelRise/SLRCompSept2011.pdf Responsive Management (2010). *Delaware Residents' Opinions on*	 Source: Delaware Shoreline and

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	studies, improved monitoring of coastal conditions, development of inundation maps, and the development of a comprehensive statewide outreach strategy around sea level rise (DCP 2011; Responsive Management 2010). As part of the Initiative, Delaware's Sea Level Rise Vulnerability Assessment was completed in July 2012 which contains a complete accounting of the extent and location of 79 resources of concern and prioritizes them. It contains data tables and a comprehensive mapping appendix and is the only such detailed vulnerability assessment to be completed at a statewide level (DNREC 2012). Meanwhile, Delaware's Sea Level Rise Advisory Committee (SLRAC) is nearing completion of a 3-year effort to assess the state's vulnerability to sea level rise and provide recommendations for adaptation. The SLRAC utilized the Vulnerability Assessment to	*Climate Change and Sea-Level Rise*. Harrisonburg, VA: Responsive Management. Retrieved from: http://www.responsivemanagement.com/download/reports/DE_SeaLevelRise_Report.pdf Delaware Coastal Programs, Department of Natural Resources and Environmental Control (DNREC, 2012). *Preparing for Tomorrow's High Tide: Sea Level Rise Vulnerability Assessment for the State of Delaware*. Retrieved from: http://www.dnrec.delaware.gov/coastal/Pages/SLR/DelawareSLRVulnerabilityAssessment.aspx.	Waterway management Section

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	guide development of adaptation options for the state, which have undergone significant public review. A total of 61 options have been developed and presented to the public at a series of public engagement sessions. These options will form the backbone of the sea level rise adaptation plan for the state (available online at: http://de.gov/adaptationengagement). In addition, several state resource agencies have undertaken adaptation planning. For example, Delaware's Division of Fish and Wildlife is actively engaged in planning a retreat strategy for several of its freshwater coastal impoundments. At the local level, all but one incorporated town in Delaware along the coast are actively engaged in increasing resiliency to coastal storms and sea level rise through a number of on-the-ground projects. Planning is facilitated with resources and		

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	funding by Sea Grant and Delaware Coastal Programs.		
Maryland's Comprehensive Strategy for Reducing Vulnerability to Climate Change has a strong initial focus on sea level rise and coastal hazards.	With 6% of Maryland's state territory below 5 ft (1.5m), the state's exposure to sea level rise was one of the main drivers behind its preparation of the state's Climate Action Plan (MDCCC 2008: p.1). A key component of the Action Plan is the Comprehensive Strategy to Reduce the State's Vulnerability to Climate Change. The Strategy addresses both short- and long-term adaptation needs for sea level rise and coastal storms and recommends detailed strategies to reduce impacts to existing and future built environments; human health, safety and welfare; and natural resources and resource-based industries. Its goals are to protect and restore Maryland's natural shoreline and its resources; to promote programs and policies aimed at the avoidance and/or reduction of future impacts from sea level rise; to enhance preparedness; and to avoid assumption of the financial risk of (re)development in highly hazardous coastal areas (ARWG 2008; DNR 2012). In 2011, the State released a second component of its adaptation	Maryland Commission on Climate Change (MDCCC, 2008). *Climate Action Plan: Interim Report to the Governor and the Maryland General Assembly*. Retrieved from: http://www.mdclimatechange.us/ewebeditpro/items/O40F14798.pdf Maryland Department of Natural Resources, Coastal Program (2000). A Sea-level rise Response Strategy for the State of Maryland. Annapolis, MD. Retrieved from: http://dnrweb.dnr.state.md.us/download/bays/sea_level_strategy.pdf Maryland Department of Natural Resources (DNR, 2012). Fighting Climate Change to Secure a Sustainable Future for Maryland (website), Annapolis, MD. Retrieved from: http://www.dnr.state.md.us/climatechange/ (with access to all relevant sea level rise programs and documents) Maryland Commission on Climate Change, Adaptation and Response Working Group (ARWG, 2008).	 Example of a living shoreline: The shoreline was stabilized using sand fill and dredge material, coir fiber logs, wetland plans, submerged aquatic vegetation, an oyster reef breakwater, and fish habitat structures. Source: http://celebrating200years.noaa.gov/transformations/habitat_restoration/HorseHdafter.html

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	strategy, outlining strategies specific to human health; agriculture; forest and terrestrial ecosystems; bay and aquatic environments; water resources; and population and infrastructure. Maryland has moved forward with implementation of both components and has adopted several new state-level policies in response. Maryland's DNR issued an agency-wide climate change policy in 2010, establishing practices and procedures related to climate change and new land investments, facility siting and design, habitat restoration, government operations, research and monitoring, and resource planning (DNR, 2010). In 2012, Governor Martin O'Malley signed the Climate Change and CoastSmart Construction Executive Order, directing that all new and reconstructed state structures, as well as other infrastructure improvements, be planned and constructed to avoid or minimize future flood damage. Through its CoastSmart Program, the state supports local communities in developing strategies to prepare for and reduce the impacts from coastal	Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change. Phase I: Sea-level Rise and Coastal Storms. Retrieved from: http://www.dnr.state.md.us/climatechange/ Maryland Department of Natural Resources (DNR, 2010). Building Resilience to Climate Change. Policy No. 2010:11, Annapolis, MD. Retrieved from: http://www.dnr.state.md.us/dnrnews/pdfs/climate_change.pdf Maryland's CoastSmart Program: http://www.dnr.maryland.gov/CoastSmart/ (see also related articles at: http://dnr.maryland.gov/ccp/publications.asp) Chesapeake Bay Sea-level Rise Impacts and Adaptation website: http://www.chesapeakeadaptation.org/	

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	hazards and climate change.		
The Hampton Roads area, including the City of Norfolk, Virginia, is working to reduce recurrent flooding and impacts on coastal infrastructure.	Residents of Hampton Roads – the Norfolk-Virginia Beach metropolitan area – deal with the impacts of sea level rise and growing flooding risks on an ongoing basis (Kobell 2012). Carrying the distinction of having the highest rate of relative sea level rise along the Atlantic seaboard of the US (due to both land subsidence and global sea level rise), the area around Virginia's second-largest city, Norfolk, regularly experiences high-tide and storm-related flooding, undercutting coastal roads, and impacting property values, historical buildings, and business activity (Fears 2012; Lehner 2012; Stiles 2012a). Ever since Hurricane Isabel in 2003 wrecked havoc in coastal Virginia (including extensive flooding at the Langley Air Force Base), communities, federal agencies (DoD, Navy and NASA) and others in the Hampton Roads area are concerned with the impacts of sea level rise. The work of federal agencies in particular is creating	Kobell, Rona (2012). Sea level along Chesapeake rising faster than efforts to mitigate it. Chesapeake Bay Journal, January 2012, retrieved from: http://www.bayjournal.com/article/sea_level_along_chesapeake_rising_faster_than_efforts_to_mitigate_it. Fears, D. (2012). Built on sinking ground, Norfolk tries to hold back tide amid sea-level rise. *The Washington Post*, June 17. Retrieved from: http://www.washingtonpost.com/national/health-science/built-on-sinking-ground-norfolk-tries-to-hold-back-tide-amid-sea-level-rise/2012/06/17/gJQADUsxjV_story.html. Lehner, Peter (2012). When Global Warming hits Home (Literally). *Thinkprogress*, May 16, 2012. Retrieved from http://thinkprogress.org/climate/2012/05/16/483019/when-global-warming-hits-home. Stiles, S. (2012a). Rising Sea Levels Threaten Historic Coastal Cities.	 Flooding of Langley Air Force Base at Norfolk, VA during Hurricane Isabel on September 19, 2003. Source: U.S. Air Force photo/Tech. Sgt. Ben Bloker A few innovative legislators have moved the planning ahead, despite state agency lack of leadership - neat adaptation study is underway now. However, there is no real work beyond planning - the case across the country. We are planning but the next phase of taking action is more difficult - see the NC story, or the story of a development we opposed, based on SLR.

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	some urgency for municipalities to follow suit. In 2008, the now-disbanded Virginia Climate Change Commission (Wetlands Watch 2009) released recommendations for adaptation. Meanwhile, with funding from USGS and others, high-resolution LIDAR maps are being produced for the entire shoreline. Since then, the state legislature called for a study on "recurring coastal flooding" and possible adaptation measures, which was released in January 2013. The Recurrent Flooding Study addresses all localities in Virginia's coastal zone and recommends that the state anticipate 1.5 feet of sea level rise in the next 20 to 50 years. It also recommends a variety of potential adaptation strategies including rolling easements, setbacks, and shoreline protection structures (DLAS 2013). Local agencies are helping to	*National Trust for Historic Preservation Forum Bulletin*, April 20, 2012. Retrieved from: http://www.preservationnation.org/forum/library/public-articles/sea-level-rise-and-its-effect.html Stiles, Jr. William A. (2012b). A "Toolkit" For Sea Level Rise Adaptation in Virginia. In: *Sea Level Rise and Coastal Infrastructure: Predictions, Risks, and Solutions*, Ayyub, B. M. and Kearney, M. eds., Monograph No. 6, Americans Council on Civil Engineering Council on Disaster Risk Management, pp. 78-100. Wetlands Watch (2009) Summary of Natural Resources/Shoreline Adaptation Strategy Recommendations of the Virginia Commission on Climate Change. Retrieved from http://wetlandswatch.org/Portals/3/WW%20documents/Adap_Strat_adopted_VCCC_062109.pdf. University of Virginia, Institute for Environmental Negotiation (2012) Community Resilience in Coastal	

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	determine the extent of the risk and possible adaptation options (e.g., Stiles 2012b), while the City of Norfolk (2012), regional planning district commissions (MPPDC 2012; HRPDC 2010), and local groups (e.g., University of Virginia 2012; Wetlands Watch 2012; TNC 2011; HRCCE 2012) are working to engage local elected officials, community leaders and community residents in listening sessions, focus groups, and educational events to build awareness and common understanding of the problems.	Virginia (website). Retrieved from: http://www.virginia.edu/ien/sealevelrise/ Hampton Roads Center for Civic Engagement (HRCCE, 2012): http://hamptonengages.com/ Wetlands Watch's Adaptation Page (2012): http://wetlandswatch.org/WetlandScience/SeaLevelRise/SeaLevelRiseAdaptation.aspx The Nature Conservancy (TNC, 2011). *The Eastern Shore of Virginia: Strategies for Adapting to Climate Change*. Report from the Eastern Shore Climate Change Adaptation Strategies Workshop. TNC: Nassawadox, VA and Charlottesville, VA. Retrieved from: http://conserveonline.org/workspaces/e-shore-va-cc-adaptation/documents/the-eastern-shore-of-virginia-strategies-for-0/view.html Middle Peninsula Planning District Commission (MPPDC, 2012). *Initiating Adaptation Public Policy Development. Phase 3*. Retrieved from:	

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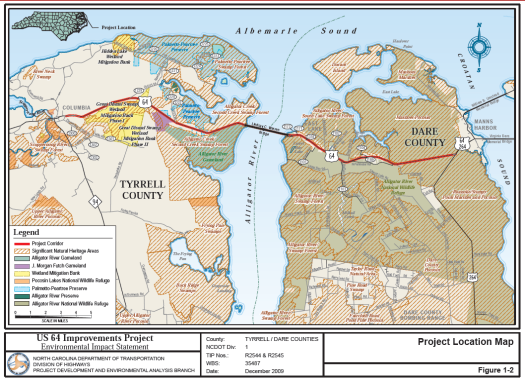
		http://www.mppdc.com/articles/service_centers/EnvironmentalCommunity%20Development/Phase_3_Climate_Change.pdf Hampton Roads Planning District Commission (HRPDC, 2010). *Climate Change in Hampton Roads: Impacts and Stakeholder Involvement*. Hampton Roads, VA. Retrieved from: http://www.hrpdcva.gov/Documents/Phys%20Planning/2010/Climate_Change_Final_Report_All.pdf City of Norfolk (2012). Flood Awareness & Mitigation (website). Retrieved from: http://www.norfolk.gov/flooding/ Division of Legislative Automated Services (DLAS) (2013). Recurrent Flooding Study for Tidewater Virginia. Richmond, VA. Retrieved from: http://issuu.com/vims/docs/recurrent_flooding_study_web_1_#download	
Southeast/Caribbean			

Short tag line (on graphic)	Extended description (clickable or on accompanying pdf)	References (with extended text)	Graphic/Photo to accompany extended description (not on graphic)
NC Department of Trans-portation is raising the road bed of US Highway 64 to account for future sea level rise.	In the course of expanding US Highway 64 between Raleigh and the Outer Banks from a two-lane road to a four-lane divided highway, the North Carolina Department of Transportation is also raising the roadbed by four feet, which includes 18 inches to allow for higher future sea levels (Henderson, 2011; Titus, 2002; USACE 2012). The project is part of the State's strategic transportation improvement plan, expected to benefit the local economy, allow timely upgrade of critical infrastructure, and enable communities to meet required hurricane evacuation times. With building future sea level into the project, these benefits will extend further into the future.	Henderson, B. (2011) Rising Waters Threaten the Coast Of North Carolina. *The Charlotte Observer*, January 18, online. Titus, J. 2002. Does Sea-Level Rise Matter to Transportation Along the Coast? In *The Potential Impacts of Climate Change on Transportation*, Summary and Discussion Papers, Federal Research Partnership Workshop, Brookings Institute Washington, DC, Oct. 1-2, pp. 135-150. US Army Corps of Engineers (USACE, 2012). Chapter 2 In: Draft Environmental Impact Statement: US 64 Improvements Project (R 2544/5). Retrieved from: http://www.saw.usace.army.mil/WETLANDS/Projects/US64Improvements/	 Source: USACE (2012), their Figure 1.2

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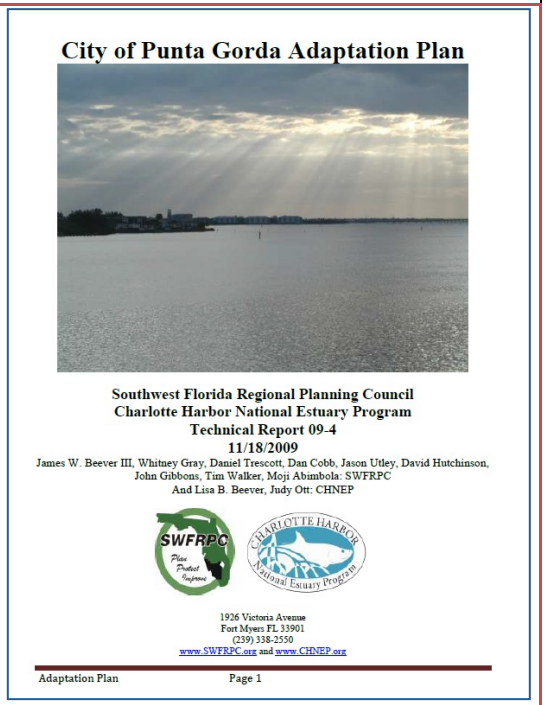
The City of Charleston upgraded stormwater pumps and sewer systems to reduce tidal flooding.	Charleston, SC faces periodic flooding that occurs during extreme high tides. Salt water backs up in storm drains and can cause hazardous road conditions, disrupting traffic patterns and occasionally forcing businesses to close (NOAA CSC 2011). Damage to buildings and vehicles from saltwater is occurring but difficult to track. Since the early 1920s, sea levels in Charleston Harbor have increased by 3.15 +/- 0.25 mm/yr (NOAA 2012). In 2010, the high tide threshold of 7 feet or more above mean lower low water (when roads flood) was crossed 19 times (NOAA CSC 2011). (For a recent example, see abcnews, 2012) To address the tidal flooding problems in the City, Charleston has completed a number of projects. For example, tidal flooding has been reduced through the installation of backflow preventers, road elevation, traffic flow modifications, and building and upgrading several stormwater pump stations (NOAA CSC	NOAA Coastal Services Center, South Carolina Sea Grant Consortium, City of Charleston (2011). *Today's Flood Is Tomorrow's High Tide*. SCSGC-G-11-01, Charleston, SC: CSC. Retrieved from: http://www.csc.noaa.gov/digitalcoast/_/pdf/chsflood2.pdf ABCnews (2012). Rain, tide cause flooding problem in Charleston area. June 6, 2012. Retrieved from: http://www.abcnews4.com/story/18714748/flooding-downtown-caused-by-tide NOAA (2012). Tides & Currents: Mean Sea Level Trend Charleston, South Carolina. Retrieved from: http://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8665530 Koob, Lindsay (2007). Under The Sea: Greetings from Charleston's underwater future. *Charleston City Paper*, September 12, 2007. Retrieved from: http://www.charlestoncitypaper.com/charleston/under-the-	 Source: NOAA Coastal Services Center (2011)

Short tag line (on graphic)	Extended description (clickable or on accompanying pdf)	References (with extended text)	Graphic/Photo to accompany extended description (not on graphic)
	2011). Long-term sea level rise trends (5.5 inches by 2030 or 13 inches by 2050 above 2008 levels; Tebaldi et al. 2012) will require significantly greater efforts in the future (Kobb 2007; see also risingsea.net)	sea/Content?oid=1111416 Risingsea.net (n.d.) Sea-Level Rise Planning Maps: Charleston South Carolina and Vicinity. Retrieved from: http://plan.risingsea.net/view/S17_Charleston_central_west_legend_moderate.html Tebaldi, C. et al. (2012). Modeling sea-level rise impacts on storm surges along US coasts. *Env. Res. Letters* 7 (2012) 014032 (doi:10.1088/1748-9326/7/1/014032).	
Charlotte Harbor National Estuary Program and City of Punta Gorda, Florida involved community stakeholders in its adaptation planning process.	After Charlotte Harbor (CHNEP) became a Climate-Ready Estuary under the National Estuary Program and conducted a vulnerability assessment (CHNEP 2010), the City of Punta Gorda was interested in partnering with CHNEP and the Southwest Florida Regional Planning Council (SWFRPC) to develop an adaptation plan for the City. One of six pilot programs, the initial climate-ready estuary vulnerability assessment was funded by the US Environmental Protection Agency (EPA). The *Punta Gorda Adaptation Plan* is notable in its technical	City of Punta Gorda (2009). City of Punta Gorda Adaptation Plan. Southwest Florida Regional Planning Council, Charlotte Harbor National Estuary Program Technical Report 09-4, eds. Beever J. et al. Retrieved from: http://www.cakex.org/sites/default/files/Punta%20Gorda.pdf City of Punta Gorda Regular City Council Meeting Minutes, November 18, 2009. Retrieved from: http://www.ci.punta-gorda.fl.us/userdata/cityclerk/20091118m.pdf Charlotte Harbor NEP's Charlotte Harbor Regional Climate Change Vulnerability Assessment, 2010.	

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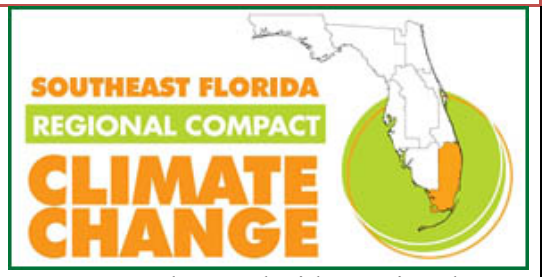
	detail, the extensive public involvement in generating priorities, impacts, and adaptation strategies; it also acknowledges the need for sophisticated communication strategies (multi-modal, cooperative, emphasis on transparency etc.) with city residents. In the lead up to engaging the community in developing in the planning process, the city conducted a survey about climate change attitudes.	Retrieved from: http://www.chnep.org/projects/climate/VulnerabilityAssessment2-19-10.pdf	Source: Cover of Punta Gorda's Adaptation Plan
Southeast Florida Regional Climate Change Compact designated Adaptation Action Areas.	In January 2010, four coastal counties in Southeast Florida - Broward, Miami-Dade, Palm Beach and Monroe Counties - came together to create a Regional Compact, with the goal of collaborating to foster sustainability and climate resilience at a regional scale. As a first step, the four counties agreed to use consensus sea level rise projections in their individual efforts (Appendix D). The Compact also developed a Regional Climate Action Plan (RCAP), finalized and ratified by all in 2012 (SEFRCCC 2012), which identified the need to designate Adaptation Action Areas – areas particularly vulnerable to the impacts of climate	SE Florida Regional Climate Change Compact website: http://www.southeastfloridaclimatecompact.org/ SE Florida Regional Climate Change Compact (SEFRCCC, 2012). *A Region Responds to a Changing Climate: Southeast Florida Regional Climate Change Compact Regional Climate Action Plan*. Retrieved from: http://southeastfloridaclimatecompact.org/compact-documents/ Appendix D (of SEFRCCC 2011): *A Unified Sea-Level Rise Projection for Southeast Florida*. Prepared by the	 Source: Southeast Florida Regional Climate Change Compact (logo)

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	change and sea level rise. In January 2011, the four counties adopted policies related to the creation of Adaptation Action Areas (AAAs) and jointly advocated for the definition of AAAs in front of the Florida Legislature. Also in 2011, the Legislature adopted the Community Planning Act, HB 720, which formally recognizes AAAs. The Compact continues to promote the concept at the federal level. With the support of members of Congress, the Compact Counties requested consideration by Congress to fund AAAs through the Interior and Environment and Related Agencies Appropriations bill (Appendix F of the regional climate action plan, 2012). A Work Group of the Compact conducted inundation mapping and vulnerability analyses as a basis for planning (SFRCC Inundation and Vulnerability Assessment Work Group 2012). Cities throughout the region are adopting Mayors' Pledges in support of the RCAP and to consider alignment and integration with city plans. This will help realize the	Technical Ad hoc Work Group. Retrieved from: http://southeastfloridaclimatecompact.org/pdf/Sea%20Level%20Rise.pdf Appendix F (of SEFRCCC 2011): Florida Department of Community Affairs, Division of Community Planning, Comprehensive Planning (2011). *Adaptation Action Area*. Retrieved from: http://www.southeastfloridaclimatecompact.org/documents/AppF_AAA.pdf Southeast Florida Regional Climate Change Compact Inundation Mapping and Vulnerability Assessment Work Group (2012). Analysis of the Vulnerability of Southeast Florida to Sea Level Rise. Retrieved from: http://southeastfloridaclimatecompact.org/pdf/vulnerability-assessment.pdf For cities that have signed Mayor's Pledges, see: http://southeastfloridaclimatecompact.org/mayors-climate-action-pledge/.	

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	recommendations of the RCAP also at the local level.		
Gulf Coast			
Mississippi-Coastal Improvements Program includes buy-outs and relocation.	As part of the Mississippi Coastal Improvements Program, the US Army Crops of Engineers offers a number of structural, environmental and non-structural program elements to improve coastal protection and resilience in the face of hurricanes and rising seas. Pending federal appropriations, property owners in high-hazard areas can select to participate in a buy-out program or to have their home relocated out of the high-hazard areas. The MsCIP comprehensive plan for coastal Mississippi aims to achieve hurricane and storm damage reduction, reduce salt water intrusion and shoreline erosion, complete other water-related projects, and preserve fish and wildlife through habitat restoration and protection. While initiated after recent hurricane damages and not	US Army Corps of Engineers, Mobile District (2012). MsCIP (Mississippi Coastal Improvement Program) website. Retrieved from: http://www.sam.usace.army.mil/mscip/docs/Comprehensive_Plan_Elements.pdf MsCIP plan elements: http://www.sam.usace.army.mil/mscip/docs/Comprehensive_Plan_Elements.pdf	 Hurricane Katrina damage in Gulfport, MS – one of the motivations for the MsCIP. Source: FEMA

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	directly motivated by climate change, the project will help prepare for expected climate change impacts.		
2012 Louisiana Coastal Master Plan ambitiously aims to protect and restore low-lying land.	The State of Louisiana is openly acknowledging the crisis its coastal areas are facing: a delta cut off from its source of sediment and the highest rates of relative sea level rise in the nation (1,880 square miles of land have already been lost over the past 80 years, and the loss is continuing); growing vulnerability of communities to hurricanes and coastal flooding; and related detrimental impacts on coastal homes, tribes, fisheries, infrastructure and industry (State of Louisiana 2012; see also e.g. ITEP 2008; *Stories of Change* 2012). In 2005, the State Legislature created a Coastal Protection and Restoration Authority (CPRA), whose mandate is to develop, implement and enforce a comprehensive master plan. The most recent Master Plan was released, after extensive	State of Louisiana (2012). *Louisiana's Comprehensive Master Plan for a Sustainable Coast*. Retrieved from: http://issuu.com/coastalmasterplan/docs/coastal_master_plan-v2?mode=window&layout=http://coastalmasterplan.la.gov/issuu/mpmar2012/layout.xml Eilprin, J. (2012). As climate changes, Louisiana seeks to lift a highway. *The Washington Post*, March 18, 2012. Retrieved from: http://www.washingtonpost.com/national/health-science/as-climate-changes-louisiana-seeks-to-lift-a-highway/2012/03/12/gIQAJoEQLS_story.html Schwartz, J. (2012). Vast Defenses Now Shielding New Orleans, *The New York Times*, June 12, 2012.Retrieved from: http://www.nytimes.com/2012/06/15/us/vast-defenses-now-shielding-new-orleans.html?pagewanted=all Institute for Tribal Environmental	 Flooding of coastal road along the Louisiana coast during Hurricane Lili in 2002 on Highway 1 Source: NOAA (Tides and Currents)

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	stakeholder and expert input, in 2012. In March 2013, the CPRA unanimously approved a $767.3 million annual plan for coastal restoration and flood protection that calls for spending more than $640 million on 117 projects during the 2014 fiscal year. The plan requires final approval from the state legislature (CPRA 2013). By 2060, the state hopes to have no net land loss anymore, an effort that would require at least $50 billion in funding. Louisiana is also trying to elevate the crucial state Highway 1 but requires federal funds to undertake the massive infrastructure upgrade (Eilprin 2012) and – as another example of structural protection – the City of New Orleans is now protected by a massive storm barrier (Schwartz 2012).	Professionals (ITEP, 2008). *Biloxi-Chitimacha-Choctaw Indians: Rising Tides*. Tribal Climate Change Profile. Technical Input Provided to the NCA. *Stories of Change (2012): Coastal Louisiana Tribal Communities' Experiences of a Transforming Environment.* Workshop Report, Technical Input into the National Climate Assessment. Coastal Protection and Restoration Authority (CPRA): http://coastal.louisiana.gov/ CPRA (2013). *Fiscal Year 2014 Annual Plan: Integrated Ecosystem Restoration and Hurricane Protection in Coastal Louisiana*. Submitted to the Senate Natural Resources Committee, House Natural Resources and Environment Committee, Senate Transportation, Highways and Public Works Committee, and the House Transportation, Highways and Public Works Committee. Retrieved from: http:// http://coastal.louisiana.gov.	

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Entergy, America's Wetland Foundation, and Oxfam champion joint adaptation planning for America's Energy Coast.	In 2010, Entergy Corporation – one of the US's leading electric utilities – partnered with America's Wetland Foundation in producing an economic study of the growing climate change-related risks to Gulf Coast communities. It found that the region could suffer more than $350 billion in economic losses over the next 20 years if no adaptation measures were taken (Entergy and AWF, 2010). Given the cost-effectiveness of many adaptation measures (compared to doing nothing), Entergy is helping coastal communities assess their vulnerabilities and implement measures that increase coastal resilience (Tripoli 2011). The company is also partnering – with several other corporations – in *The Partnership for Resilience and Environmental Preparedness (PREP)* – a one-year pilot partnership formed to address the risks and opportunities that climate change impacts pose to businesses and the communities on which they depend (Leonard and Offenheiser 2012; Oxfam	Entergy and America's Wetland Foundation (2010). Building a Resilient Energy Gulf Coast. Retrieved from: http://entergy.com/content/our_community/environment/GulfCoastAdaptation/Building_a_Resilient_Gulf_Coast.pdf Leonard, J. W. and R.C. Offenheiser (2012). Working to cope with climate change. Guest Column, *The Times Picayune, New Orleans*, May 26, 2012. Retrieved from: http://www.nola.com/opinions/index.ssf/2012/05/working_to_cope_with_climate_c.html Tripoli, L. (2011). Facing inevitable climate losses, US corporations begin to adapt. *InsideClimateNews*, February 14, 2011. Retrieved from: http://insideclimatenews.org/news/20110214/facing-inevitable-climate-losses-us-corporations-begin-adapt Oxfam America (2011). Press Release: key companies launch partnership on climate resilience. Retrieved from: http://www.oxfamamerica.org/press/pressreleases/key-companies-launch-partnership-on-climate-resilience	 Flooding at a Texas oil refinery after Hurricane Rita, 25 September 2005 Source: FEMA, Leif Skoogfors (Wikimedia Commons)

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	America 2011).		
Texas requires rolling easements.	*Rolling easements* can be regulations or types of land ownership that prohibit hardening shore protection but allow wetlands and beaches, and/or public access rights to migrate inland as sea level rises (Titus 2011, 1998). In March 2012, the Texas state supreme court held in *Severance v. Patterson* that the public easement created by the state's Open Beaches Act "rolls" upland *only* when the shoreline moves as accretion (that is, slowly and imperceptibly), rather than as avulsion (suddenly due to a storm). Texas courts had not previously applied this ancient common law distinction, which long has governed watercourse boundary movements, to shoreline movements on the Texas Gulf Coast. The court reasoned that the state's imposition of a public easement over the owner's property after a storm moved the beach dramatically inland constituted a new easement and constituted a *per se* taking, because the public	Titus, J.G. (2011). Rolling Easements, US Environmental Protection Agency. Washington DC. 169 pp Titus, James G. (1998) *Rising Seas, Coastal Erosion, and the Takings Clause: How to Save Wetlands and Beaches without Hurting Property Owners*, 57 *MD. L. REV*. 1281: 1308–1318. See, e.g., Seaway Co. v. Att'y Gen., 375 S.W.2d 923, 936–37 (Tex Civ. App. 1964, writ ref'd n.r.e.); Matcha v. Mattox, 711 S.W.2d 95, 101 (Tex. Civ. App, 1986 writ denied); *and* Feinman v. State, 717 S.W.2d 106, 113 (Tex. App. 1986, writ ref'd n.r.e.). But now see Severance v. Patterson, No. 09-0387, 2012 WL 1059341 (Tex. Mar. 30, 2012); additional details available at: http://caselaw.findlaw.com/tx-supreme-court/1543835.html. White, I. (2010). GLO says no to 'static' easements on West End, *Galveston County Daily News,* November 26, 2010; Patterson, Jerry, Commissioner, Texas General Land Office. Letter to	 House in Surfside, TX (2003) once built wholly landward of the vegetation line is increasingly exposed to the dynamic forces of the sea. Source: James Titus

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	now enjoyed permanent physical access. The court rejected the view that the owner's rights were burdened by the rolling easement before it actually attached to her land, even though she had notice of it at the time of her purchase (Severance v. Patterson, No. 09-0387, 2012 WL 1059341 (Tex. Mar. 30, 2012)). As a result of this decision the TX General Lands Office (GLO) cancelled a beach nourishment project in Galveston (see also White 2010). Now, the GLO is negotiating with landowners: the state is requiring them to agree to dedicate rolling access easements over their property before the state will resume the publically funded nourishment project on the grounds that the state cannot use tax payer money to convey a purely private benefit (Rice 2010). For the last few decades prior to this recent case, the courts held	J. Titus, December 2010. Rice, Harvey (2010). Mayor faults 'blow to Galveston' after state halts beach project. The Houston Chronicle, November 15, 2010. Retrieved from: http://www.chron.com/business/real-estate/article/Mayor-faults-blow-to-Galveston-after-state-1708528.php.	

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	that under the State's common law of property, land along parts of the Gulf Coast were subject to a rolling easement as the shoreline shifted (see court case listed in refs). Many states require shorefront owners to convey easements before a beach nourishment project can be initiated, but Texas is the first state to require rolling easements as long as the shoreline shift resulted from slow landward encroachment of the sea rather than a storm.		
California			
San Diego Bay engaged in a multi-sector, multi-level stakeholder process to develop a first adaptation plan.	A comprehensive vulnerability assessment was conducted, and broad adaptation strategies were developed for sea level rise for San Diego Bay under the leadership of ICLEI-Local Communities for Sustainability, the San Diego Foundation, and the Tijuana River National Estuarine Research Reserve. Multiple municipalities in the greater San Diego region, several state and federal agencies, technical advisors from	ICLEI-Local Communities for Sustainability (2012). *Sea-Level Rise Adaptation Strategy for San Diego Bay*. Retrieved from: http://www.icleiusa.org/static/San_Diego_Bay_SLR_Adaptation_Strategy_Complete.pdf. Messner, S. et al. (2009). Climate Change Related Impacts in the San Diego Region by 2050. California Energy Commission, Research White Paper. Retrieved from http://www.energy.ca.gov/2009public	 San Diego Source: Wikimedia Commons, "Rctckc" (2008)

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	consultancies and academia, and the private sector (ports, etc.) were involved. While non-mandatory, the plan is a remarkable effort in bringing diverse stakeholders together and developing consensus recommendations, which will guide coordinated adaptation efforts. A climate change impacts assessment had been prepared previously (Messner et al. 2009).	ations/CEC-500-2009-027/CEC-500-2009-027-F.PDF (see also a related public outreach document from the San Diego Foundation: http://www.sdfoundation.org/Portals/0/Newsroom/PDF/Reports/Focus2050glossySDF-ClimateReport.pdf)	
California Ocean Protection Council developed sea level rise guidance for state and local governments.	The State of California has developed a statewide approach to reducing the risks from climate change impacts, summarized in the California Adaptation Strategy of 2009 (CNRA 2009; updated in 2013). Following the first adaptation strategy, in 2010, the California Ocean Protection Council (OPC) worked in conjunction with its Science Advisory Team and sixteen other State agencies through the Coastal and Ocean working group of the California Climate Action Team (CO-CAT) to develop the State of California Sea Level Rise Interim Guidance Document (CO-CAT 2010). A report by the	Hart, J.F., P. Grifman, S.C. Moser, A. Abeles, M. Meyers, S. Schlosser, and J. Ekstrom. (2012). *Rising to the Challenge: Results of the 2011 California Coastal Adaptation Needs Assessment*. USC Sea Grant, Los Angeles, CA. Retrieved from: http://www.usc.edu/org/seagrant/research/climateadaptsurvey/SurveyReport_FINAL_OnlinePDF.pdf National Research Council (2012). *Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future.* Committee on Sea-Level Rise in California, Oregon, and Washington, Board on Earth Sciences and Resources and Ocean Studies Board, Division on	 King tide on January 22, 2012, San Francisco, Embarcadero, gave preview of higher sea levels Source: Sergio Ruiz

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	NRC (2012) supported an update of that guidance in 2013. In March 2011, the OPC adopted a non-binding sea level rise resolution asking State agencies to incorporate consideration of sea level rise into all decisions and programs (including funding) (OPC 2011). While there is no mandatory local adaptation planning at this time, the State is currently encouraging adaptation at the local level through state funding programs (e.g., State Coastal Conservancy, Strategic Growth Council, Department of Water Resources), requiring that entities applying for funds conduct sea level rise vulnerability assessments (Hart et al. 2012). The state's Climate Adaptation Policy Guide (CalEMA and CNRA, 2012), oriented especially toward local communities, is aimed at assisting with such assessments and local adaptation planning.	Earth and Life Studies. Washington, DC: National Academies Press. Retrieved from: https://download.nap.edu/login.php?record_id=13389&page=%2Fcatalog.php%3Frecord_id%3D13389. California Natural Resources Agency (CNRA, 2009). The California Climate Adaptation Strategy 2009. A Report to the Governor of the State of California, Natural Resources Agency, Sacramento, CA (2009 and 2013 update available from: http://www.climatechange.ca.gov/adaptation/strategy/index.html). California Ocean Protection Council (OPC, 2011). Resolution of the California Ocean Protection Council on Sea-Level Rise. Available at: http://www.opc.ca.gov/2011/04/resolution-of-the-california-ocean-protection-council-on-sea-level-rise/ Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) (2010). State of California Sea-Level Rise Interim Guidance Document. Available at: http://opc.ca.gov/webmaster/ftp/pdf/agenda_items/20110311/12.SLR_Resolution/SLR-Guidance-Document.pdf	

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		Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT), with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust (2013). State of California Sea-Level Rise Guidance Document. Retrieved from: http://www.opc.ca.gov/webmaster/ftp/pdf/docs/2013_SLR_Guidance_Update_FINAL1.pdf CalEMA and CNRA (2012). California Adaptation Policy Guide. Public Review Draft, April, 2012, Sacramento, CA. Retrieved from: http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html.	
Bay Conservation and Development Commission passed Bay Plan Amendment.	The San Francisco Bay Conservation and Development Commission (BCDC), one of California's three coastal agencies, has a mandate to protect tidal wetlands in San Francisco Bay by regulating fill, dredging, and Bay shoreline development. After years of studies (BCDC 2011) and	BCDC governing law, the San Francisco bay Plan: http://www.bcdc.ca.gov/laws_plans/plans/sfbay_plan.shtml Bay Plan Amendment: http://www.bcdc.ca.gov/proposed_bay_plan/bp_amend_1-08.shtml BCDC (2011). *Living With a Rising*	

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	extensive public input, the Commission in October 2011 amended its governing legislation – the Bay Plan (Amendment 1-08) – to advance climate change and sea level rise adaptation through wetland restoration, creation of buffer zones to allow for erosion losses, accommodation of landward migration of salt marshes, and upgrading of shoreline protection (BCDC 2011). Developers seeking permits to build within BCDC's narrow jurisdiction (100 feet from the shoreline) are (1) required to conduct a risk assessment that takes flooding under different sea level rise scenarios into account and (2) document plans for how they will structurally and financially deal with adaptation when sea level becomes an imminent risk to their building. BCDC has postponed more stringent adaptation measures until a regional consortium of agencies (Joint Policy Committee, JPC) develops a Bay Area wide adaptation strategy (JPC 2012).	*Bay: Vulnerability and Adaptation in San Francisco Bay and on the Shoreline*. BCDC: San Francisco. Retrieved from: http://www.bcdc.ca.gov/BPA/LivingWithRisingBay.pdf. Joint Policy Committee's regional efforts in developing an adaptation strategy: http://www.abag.ca.gov/jointpolicy/	Treasure Island, San Francisco Bay Source: Albrecht Conz, Wikimedia Commons, 2007

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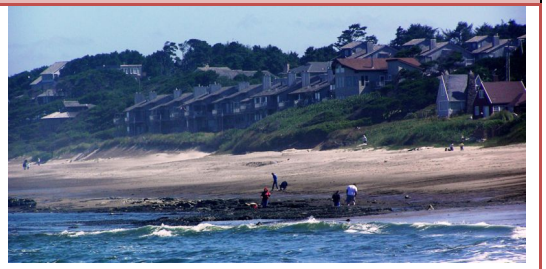
Pacific Northwest			
Oregon Sea Grant surveyed its coastal professionals on preparedness for local climate change impacts.	In 2009, Oregon Sea Grant conducted a first survey of coastal professionals and found that decision-makers were concerned about climate change and how it may affect the Oregon Coast, but few felt ready to take action at this time for lack of a sense of urgency, inadequate information, and insufficient funding (Borberg et al. 2009). In response to survey findings, Oregon Sea Grant developed extensive outreach materials, including written materials and videos, to increase understanding among coastal professionals (available at http://seagrant.oregonstate.edu/climate-change). In 2012, elected officials and coastal professionals were surveyed again, finding that most believe and are quite sure that their communities will experience the local effects of climate change, but many (40 percent) were still not involved in adaptation planning (Winters	Borberg, J., J. Cone, L. Jodice, M. Harte, and P. Corcoran (2009). An Analysis of a Survey of Oregon Coast Decision Makers Regarding Climate Change. ORESU-S-09-001, Oregon Sea Grant, Corvallis, OR. Retrieved from: http://seagrant.oregonstate.edu/sgpubs/analysis-survey-coast-decision-makers Winters, K. (2012). Coastal Climate Change Survey Results 2012. Retrieved from: http://seagrant.oregonstate.edu/sites/default/files/sgpubs/onlinepubs/s13001-accessible.pdf Oregon Sea Grant Climate Change Outreach (website): http://seagrant.oregonstate.edu/climate-change	 Lincoln Beach, Oregon – beach homes and beach combing. Source: Scott Catron, Wikimedia Commons (2005)

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	2012). Lack of agreement over the importance of climate change effects and lack of a sense of urgency were found to be the greatest hurdles to adaptation planning. These findings will continue to inform Oregon Sea Grant extension experts in their outreach to coastal communities.		
Swinomish Tribe's Climate Change Initiative highlights special challenges of coastal tribes.	The Swinomish Climate Change Adaptation Strategy is a model for integrative, multi-sectoral planning for the impacts of climate change. It speaks frankly to the daunting truths of climate change, and frames the adaptation challenge as one the tribe can be confident in meeting due to its long history in adapting to daunting challenges before. The adaptation plan was developed – as is the traditional approach in tribal societies – with considerable respect for and solicitation of tribal members' views and opinions. Community communications were lead by a Climate Change Education and Awareness Group. The plan reflects that experience and offers "Practical Tips for communicating and implementing actions." Due to the particular legal status of native tribes in the US, legal issues feature significantly in the document as does	Swinomish Indian Tribal Community, Office of Planning and Community Development (2010). Swinomish Climate Change Initiative Climate Adaptation Action Plan. La Conner, WA. Retrieved from: http://www.swinomish.org/climate_change/Docs/SITC_CC_AdaptationActionPlan_complete.pdf	 The Climate Change Education and Awareness Group. Source: Swinomish Adaptation Plan

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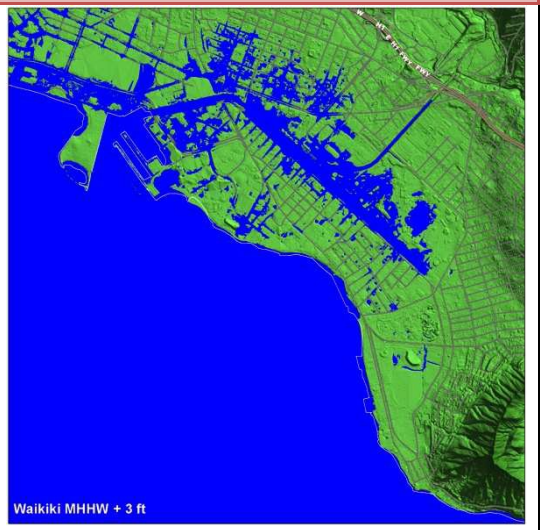
	the fact that their jurisdiction, access to resources and ability to move is constrained by reservation boundaries (sacred land). Coastal land loss is particularly challenging as it reduces reservation land forever.		
Hawaíi/Pacific Islands			
Researchers map sea level rise in Honolulu to help communities assess risks.	Mapping the potential impacts of sea level rise provides a basis for developing adaptation guidelines and choosing among a range of coastal land-use policy tools (Culver et al., 2010; Codiga and Wager, 2011). Maps allow communities to assess what is at risk and what adaptation options they have. Based on stakeholder workshops, agency surveys and interviews, and scientific and policy analysis by researchers at the University of Hawai‘i, Codiga and Wager (2011) recommended that Hawai‘i should begin preparing for sea level rise of approximately 1 ft by 2050 and around 3 ft by the end of the century in planning and regulatory decision-making. These benchmarks are within the	Marra, J.J., Keener, V.W., Finucane, M.L., Spooner, D., Smith, M.H. (eds.) (2012). Climate Change and Pacific Islands: Indicators and Impacts. Report for The 2012 Pacific Islands Regional Climate Assessment (PIRCA). Honolulu, Hawai‘i, USA. Culver, M. E., Schubel, J. R., Davidson, M. A., Haines, J., & Texeira, K. C. (eds.). (2010). *Proceedings from the Sea Level Rise and Inundation Community Workshop.* Lansdowne, MD, 3 December 2009. Retrieved from: http://www.csc.noaa.gov/publications/inundation-workshop.pdf Codiga, D., & Wager, K. (2011). *Sea-level rise and coastal land use in Hawai‘i: A policy tool kit for state and local governments*. Honolulu: Center for Island Climate Adaptation and Policy. Retrieved from	 Areas of Waikiki District, Honolulu, at or below 0.9m of the current high tide line that would be inundated by sea level rise of 3 ft. Source: PIRCA (2012: p.77)

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	NCA scenarios (see Chapter 2: Climate Science). The bulk of their report examines Hawai‘i- and county-specific land-use policy tools that can be adjusted and utilized to account for the two planning benchmarks. Using these estimates, combined with digital elevation models, the University of Hawai‘i Coastal Geology Group has developed maps to help visualize the impact of elevated sea level on the island of O’ahu (PIRCA 2012). Based on these analyses, several segments of shoreline and numerous low-lying inland areas will fall below the high-tide line later in the century as sea level rises. Low-lying areas that are not submerged will be increasingly vulnerable to inundation by high waves, storms, tsunamis, coastal flooding, and extreme tides. Along the shoreline, the impacts are already being observed, including beach erosion and waves reaching over seawalls and other structures with increased	http://icap.seagrant.soest.hawaii.edu/icap-publications Reynolds, M.H., Berkowitz, P., Courtot, K.N., and Krause, C.M. (eds.) (2012) *Predicting sea-level rise vulnerability of terrestrial habitat and wildlife of the Northwestern Hawaiian Islands*. U.S. Geological Survey Open-File Report 2012-1182, 139 pp.	

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	frequency and magnitude. In areas of Honolulu and Waikīkī within five to eight blocks of the ocean, the potential is growing for basements to flood, ground floors to be splashed by storm wave run-up, seawater backing up in storm drains, and increased flooding following heavy rains. Elsewhere on the islands, USGS provided first-ever high-resolution topographic and sea level rise impact estimates to better support wildlife management in the northwestern Hawaiian Islands (Reynolds et al. 2012).		
USGS helps monitor saltwater intrusion on Majuro Atoll, Marshall Islands.	Majuro Atoll in the Marshall Islands is a low-lying island group that is extremely vulnerable to droughts and saltwater intrusion into its shallow aquifer. Drinking water and water for agriculture comes either from rain catchments or shallow wells (PIRCA 2012, Case Study 2.1). During dry years, the primary source of water is groundwater from shallow lenses of freshwater underlain by	Marra, J.J., Keener, V.W., Finucane, M.L., Spooner, D., Smith, M.H. (eds.) (2012). Climate Change and Pacific Islands: Indicators and Impacts. Report for The 2012 Pacific Islands Regional Climate Assessment (PIRCA). Honolulu, Hawai‘i, USA; Case study 2.1, pp.51-52.	 Source: Joel Bradshaw, 2009, Wikimedia Commons

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	brackish water. When overdrawn, saltwater contaminates this freshwater source with detrimental impacts on agriculture (such as the staple crop, taro, as well as breadfruit or banana) and other essential uses. Extremely high tides and floods also threaten freshwater sources, as occurred in 2007, destroying almost the entire taro crop. After the 1997/98 El Niño, which caused severe drought on the Majuro Atoll and other Pacific Islands, integrated rainwater and groundwater management became a top priority, with the USGS installing groundwater monitors to improve the data available in support of effective water management.		
Alaska			
Newtok, AK is relocating away from the eroding shoreline.	Newtok, Alaska, a Yup'ik Eskimo village of some 350 residents on the Ninglick River, not far from the coast in southwest Alaska, is already facing serious impacts of climate change (Feifel and Gregg 2010). The frozen ground (permafrost)	Feifel, K. and Gregg, R. M. (2010). *Relocating the Village of Newtok, Alaska due to Coastal Erosion* [Case study on a project of the Newtok Planning Group]. Product of EcoAdapt's State of Adaptation Program. Retrieved from CAKE: http://www.cakex.org/case-	

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	that the community is built on is melting, and the shoreline has receded some 83 feet per year (GAO 2004, 2009). Many houses have already been abandoned, and others are at risk of flooding during high tide (York 2012). With intense investigations of the erosion problems and possible solutions since the early 1980s, and countless public meetings later, in 2003, residents decided to relocate their village to a new site, called Mertarvik, on Nelson Island, nine miles from its current location (DCRA 2012). This option allowed the community a way to stay together and continue their subsistence lifestyle (York 2012; Dowie 2010). To access the new site, a barge landing facility and access road were built between 2009 and 2010. Now a strategic management plan is being developed to guide the relocation (DCRA 2012). Relocating the village could cost as much as $80-130 million (USACE 2009), however, it is unclear for now who will bear the	studies/1588 (Last updated July 2011) York, A. (2012). Alaskan village stands on leading edge of climate change. *Powering a Nation* (blog). Retrieved from: http://unc.news21.com/index.php/stories/alaska.html Dowie, M (2010). Relocating Newtok; A Yup'ik village determined to preserve its cultural identity faces a costly move to higher ground. *Orion Magazine*. Nov/Dec. Retrieved from: http://www.orionmagazine.org/index.php/articles/article/5928/ State of Alaska, Department of Commerce, Community and Economic Development, Division of Community and Regional Affairs (DCRA, 2012). Newtok Planning Group (website) Retrieved from: http://www.commerce.state.ak.us/dca/planning/npg/Newtok_Planning_Group.htm Government Accountability Office (GAO, 2004). Alaska Native Villages. Villages Affected by Flooding and Erosion Have Difficulty Qualifying	Newtok, Alaska Source: SECTION 117 PROJECT FACT SHEET (2008)

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	cost. The Army Corps of Engineers in 2009 determined that 178 Alaska villages had similar erosion problems, and 26 were designated "priority action communities" requiring immediate assistance to address their erosion issues.	for Federal Assistance. Testimony Before the Committee on Appropriations, U.S. Senate, June 29, 2004. GAO-04-895T, Washington, DC: GAO. Retrieved from: http://www.gao.gov/new.items/d04895t.pdf GAO, 2009). Alaska native Villages. Limited Progress has Been Made in Relocating Villages Threatened by Flooding and Erosion. GAO-09-551. Washington, DC: GAO. Retrieved from: http://www.gao.gov/new.items/d09551.pdf US Army Corps of Engineers (USACE, 2009). *Alaska Baseline Erosion Assessment*. Study Findings and Technical Report. Elmendorf Air Force Base, AK: USACE, Alaska District. Retrieved from: http://www.climatechange.alaska.gov/docs/iaw_USACE_erosion_rpt.pdf	
Great Lakes			

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Wisconsin's state adaptation plan includes emphasis on lake shorefront areas.	With 325 miles of shoreline on Lake Superior and 400 miles of shoreline along Lake Michigan, coastal land and resource protection feature prominently in Wisconsin's Climate Adaptation Plan (WICCI 2011a). Experts expect greater shore erosion and recession, increased runoff and risk of flooding, impacts on coastal wetlands, as well as impacts on the built environment, including lake ports, harbors, and marinas, water intakes, shoreline infrastructure, and the re-suspension of contaminants in lake sediment in the course of dredging. Recommended adaptation strategies focus on stabilizing or retreating from failing bluffs, reduced stormwater runoff on coastal sites and improved stormwater management (see also EPA 2008), infrastructure modifications and adjustments in dredging in harbor areas, improvements in and implementation of community comprehensive planning that account for changes in climate,	Wisconsin Initiative on Climate Change Impacts (WICCI, 2011a). *Wisconsin's Changing Climate: Impacts and Adaptation*. Nelson Institute for Environmental Studies/University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, WI. Retrieved from: www.wicci.wisc.edu. WICCI (2011b).*Climate Change and Wisconsin's Great Lakes Coastal Communities*. WICCI Coastal Communities Working Group Report. EPA (2008). *A Screening Assessment of the Potential Impacts of Climate Change on Combined Sewer Overflow (CSO) Mitigation in the Great Lakes and New England Regions (Final Report)*. U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-07/033F. retrieved from: http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=188306	

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	ecosystem protection, building adaptive capacity, and improved communication with lake shore residents (WICCI 2011b).		
Bay-Lake Regional Planning Commission updated hazard mitigation plans.	In conjunction with the Wisconsin Coastal Management Program, the Bay-Lake Regional Planning Commission (RPC) collaborates on a continual basis with Northeast Wisconsin counties along Lake Michigan and their local hazard mitigation steering committees to update existing plans so that they account for expected changes in coastal storms and shoreline erosion as a result of climate change. The RPC developed *A Guide for Hazard Mitigation Planning for Wisconsin Coastal Communities* and began providing climate change information to emergency managers and planners to help them more fully prepare for more frequent and severe impacts (OCRM, 2011: p.33; RCP 2007).	Bay-Lake Regional Planning Commission (RPC, 2007). *A Guide for Hazard Mitigation Planning for Wisconsin Coastal Communities*. Retrieved from: http://www.baylakerpc.org/media/46893/coastal%20hazards%20planning%20guide_june%202007.pdf NOAA, Office of Ocean and Coastal Resource Management (OCRM, 2011). Adapting to Climate Change: A Planning Guide for State Coastal Managers – A Great Lakes Supplement. Silver Spring, MD: NOAA. Retrieved from: http://coastalmanagement.noaa.gov/climate/adaptation.html	

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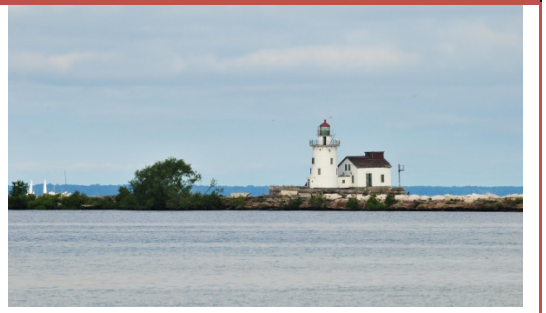
Ohio's Lake Erie Commission is in the process of developing model shoreline development legislation.	The Lake Erie Protection & Restoration Plan, originally put in place in 2000, was updated in 2008 (OLEC, 2008). The Plan explicitly recognizes climate change as one of its 10 priorities and set the goal of helping communities and land owners in the Lake Erie watershed to understand and prepare for the impacts of climate change. To aid this process, the Ohio Lake Erie Commission (OLEC) asked the Technical Advisory Committee of its "Balanced Growth" program to develop model legislation for shoreline development that recognizes climate change with input from key stakeholder groups (OLEC 2006; OCRM 2011, p.36).	Ohio Lake Erie Commission (OLEC, 2008). Lake Erie Protection & Restoration Plan 2008. Toledo, OH. Retrieved from: http://lakeerie.ohio.gov/Portals/0/Reports/2008LEPRplan.pdf Ohio Lake Erie Commission, Balanced Growth Task Force (OLEC, 2006).*Linking Land Use and Lake Erie: Best Local Land Use Practices*. Toledo, OH. Retrieved from: http://balancedgrowth.ohio.gov/ NOAA, Office of Ocean and Coastal Resource Management (OCRM, 2011). Adapting to Climate Change: A Planning Guide for State Coastal Managers– A Great Lakes Supplement. Silver Spring, MD: NOAA. Retrieved from: http://coastalmanagement.noaa.gov/climate/adaptation.html	 Source: Wikimedia Commons, Tom Bower, Cleveland West Pierhead Light - Lake Erie OH